Filosofia, Educação e Ética da Pesquisa e do Desenvolvimento Tecnológico

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Philosophy for Understanding Systems

Philosophy is necessary, even—and especially—when considering practice of a particular area of engineering. Some Reasons:

- **Philosophical assumptions can be used to justify (and critique)**
- **Philosophy can be used to help define alternatives**
- **Philosophical arguments can assist debates about methodology**
- **Philosophy helps us select and defend guidelines for practice.**
- **Fluency in philosophical debate could help critique and justify intuitive notions and ethical stances in scientific methodology.**
- **Philosophy helps us see practice in a different light.**
- **Philosophy reveals why different approaches are incompatible and cannot simply be "compared"**

Philosophy has a number of main branches, and these are what is necessary to address the issues that constitute the Frameworks :

- **Ontology:** What is the nature of electric supply systems with which we work?
- **Epistemology:**How do we come to understand and know smart grids? What constitutes good research in smart grids? How do we form conceptual structures or good models for smart grids?
- **Philosophical ethics:** What is good. Bad, normative or antinormative, problematic or to be aspired to in smart grids? What is the root motivation for smart grids?
- **Methodology:** What methods should we use in research and development? In practice how do we overcome problems or achieve our aspirations?
- **Anthropology:** What is the role of human beings in the area?
- **Critical philosophy:** What presuppositions lie at the root of any framework and what transcendental conditions are necessary for things to be possible?

Therefore, to consider, discuss, formulate a framework for any area requires some reference to philosophy.

Engineering and Philosophy Questions

Engineering / Technology Process

- Concept
- Specification
- Quantitative Analysis
- Practical Implementation
- Operation

Philosophical Approach

- Ontological - Existence Questions
- Epistemological – Nature and Scope Questions
- Methodological Questions
- Aesthetics Questions
- Moral / Ethics / Questions

Is a smart grid really necessary?
What are the essential features of a smart grid?

How can we know that a smart grid will function better than a traditional grid?

Does the design only addresses the client requirements?

Caring Vs Ethics
Need to go beyond
orms

Multidiscipline and Multidimensional Complexity of a System

How to cope with the complexity of micro, smart and super electric grids?

It is impossible to take into account the full complexity of these systems!

We focus on:

few aspects,
components or systems,
perspective of a few parties involved.

Study and design are performed on reduced realities resulting in:

missing relevant dimensions,
overlooking important interactions between technical systems,
neglecting interests of certain parties,
loss of information.

Reduced realities have to be integrated – for better or worse – into a single unity. This is the challenge for the designer. We need intuition, creativity and technical skills.

Multidiscipline and Multidimensional Complexity of System

Government, local authorities, energy suppliers, energy transporters, customers (industrial, commercial, residential), action groups, etc.

Diverse Interests:

Government and local authorities

Focus on the juridical aspect of electricity systems.

Customers

Focus on the economic, security and environment aspects of energy.

Action groups

Focus on environmental dimension of energy production and transportation

The different parties play an irreducible role and have their own specific interests and responsibilities.

Multidiscipline and Multidimensional Complexity of a System

1 - Physical aspects

Energy generation, transportation and management
Physical laws, system performance
Instabilities compromise performance / security

3 – Bio / Life Sustaining aspects

Environmental dimensions and impact

3 - Control aspects

Power over individual components / whole system
Distributed / delegated to intelligent systems

4 – Social and economical aspects

System and generated electricity have economic value
Breakdown can cause enormous economic losses

5 – Juridical and political aspects

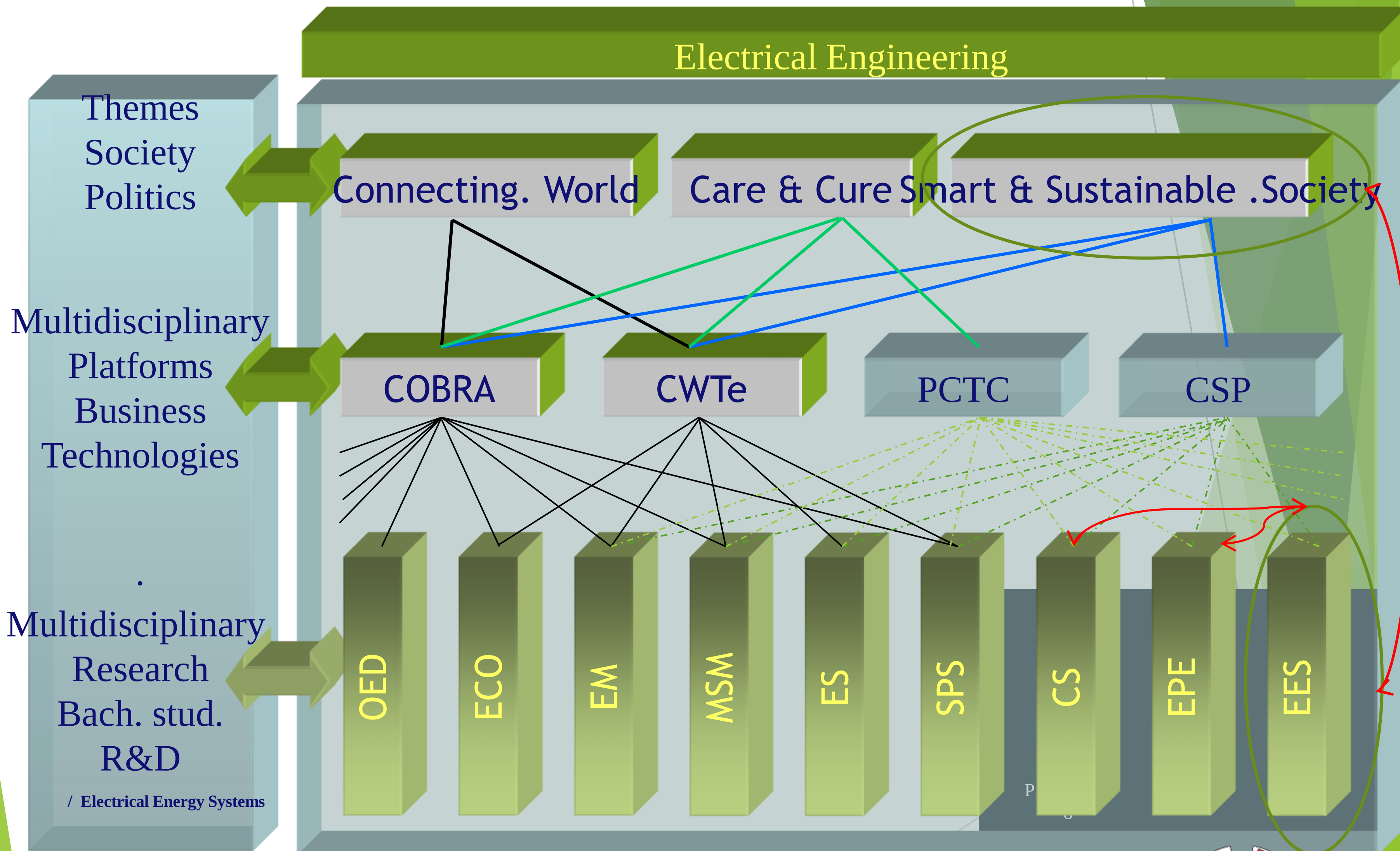
Generation and trading covered by juridical contracts.

6 - Moral aspects

We cannot live without electrical energy.
Moral obligation of energy suppliers to supply energy continuously

Thus, it can be concluded that electric energy systems function in a number of different aspects or dimensions. These aspects or dimensions have each a specific nature that is not present in the others. The specific nature of these aspects or dimensions has to be investigated in detail and integrated in the overall design and operation.

TU/e Electrical Engineering Department
Strategy and Organization



Architectures of Reference

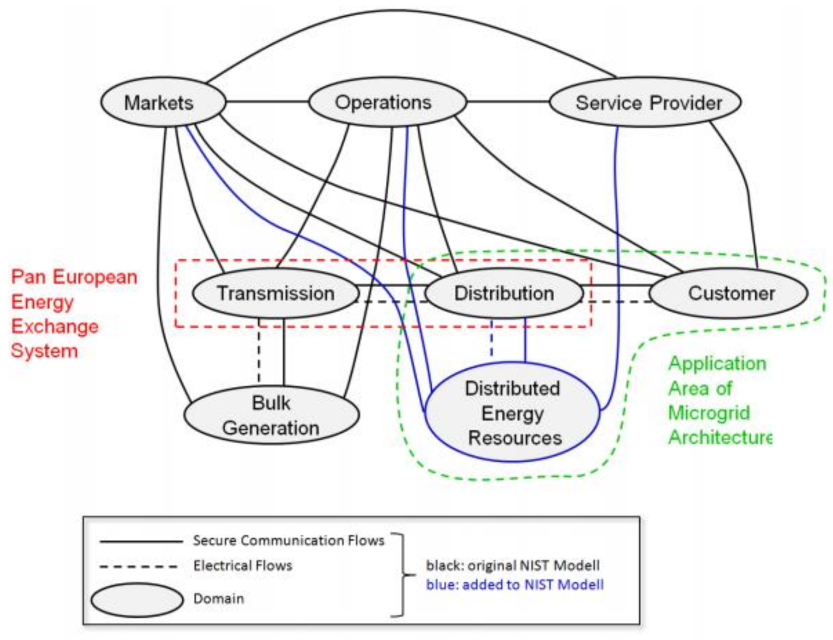


Figure 2: EU extension of the NIST Model

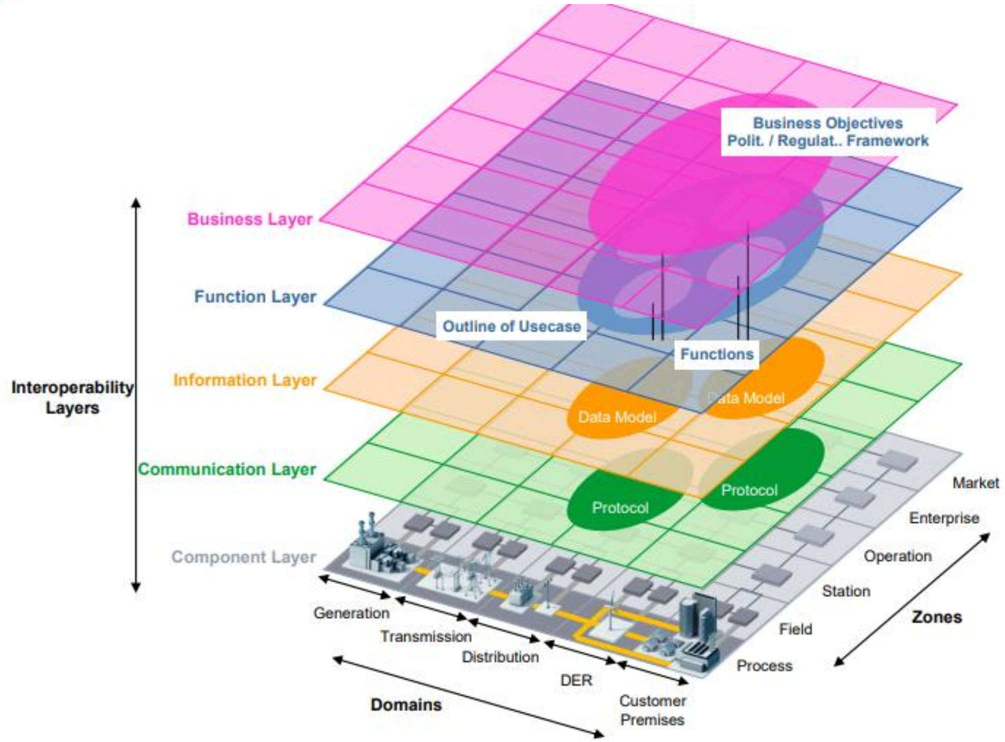


Figure 8: SGAM framework

https://ec.europa.eu/energy/sites/ener/files/documents/xpert_group1_reference_architecture.pdf

Architectures of Reference

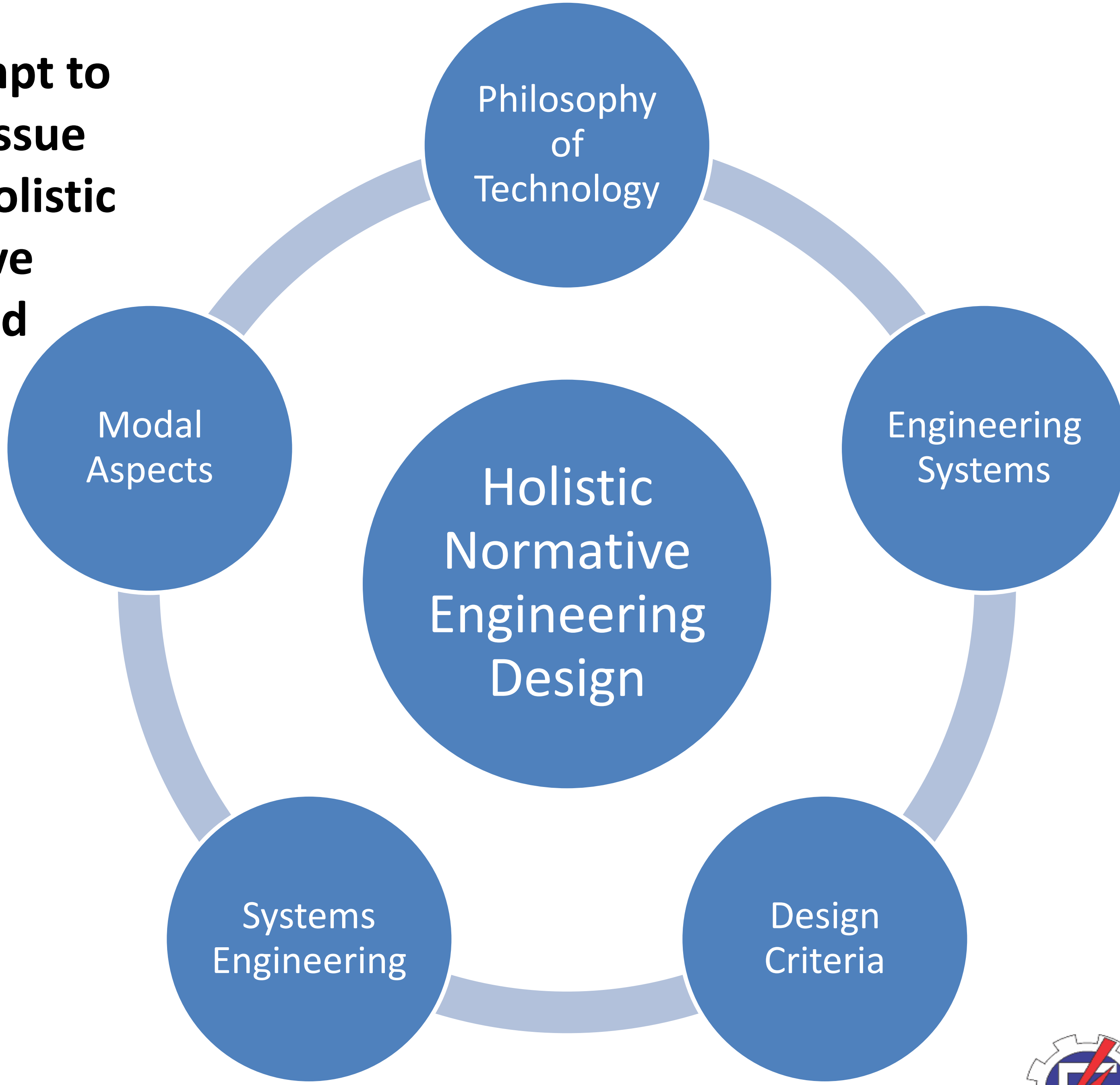
Classic Architecture Paradigm	Smarter Grid Architecture Paradigm	Comments
Focus on components	Focus on Structure	In a block diagram, the boxes are the components and the lines are the structure
Structure is received or improvised	Structure is formalized	Structure should have harsh mathematical basis
The grid can be discribed as a big circuit	Electricity markets and grid controls are related	Crentralized markets are closely related to grid controls
Sstem of systems	Network of structures	The grid comprises multiple complex structures that ar interconnected in complex ways
Large Cluster of data	Ultra-large-scale complexity	Ultra-large-scale complexity is a consequence of the network of structures
System Integration	Convergence and Platforms	Platform is a very general architectural concept tha applies broadly to system structure
Architectural elegance	Architectural quantification	The elegancy is not the goal, alignment with objectives is
Holistic Normative Engineering Design Architecture / Framework	**Broad and Integrating all Engineering and Societal Aspects**	**Smart Living Should be a Consequence**

Analytical Tools

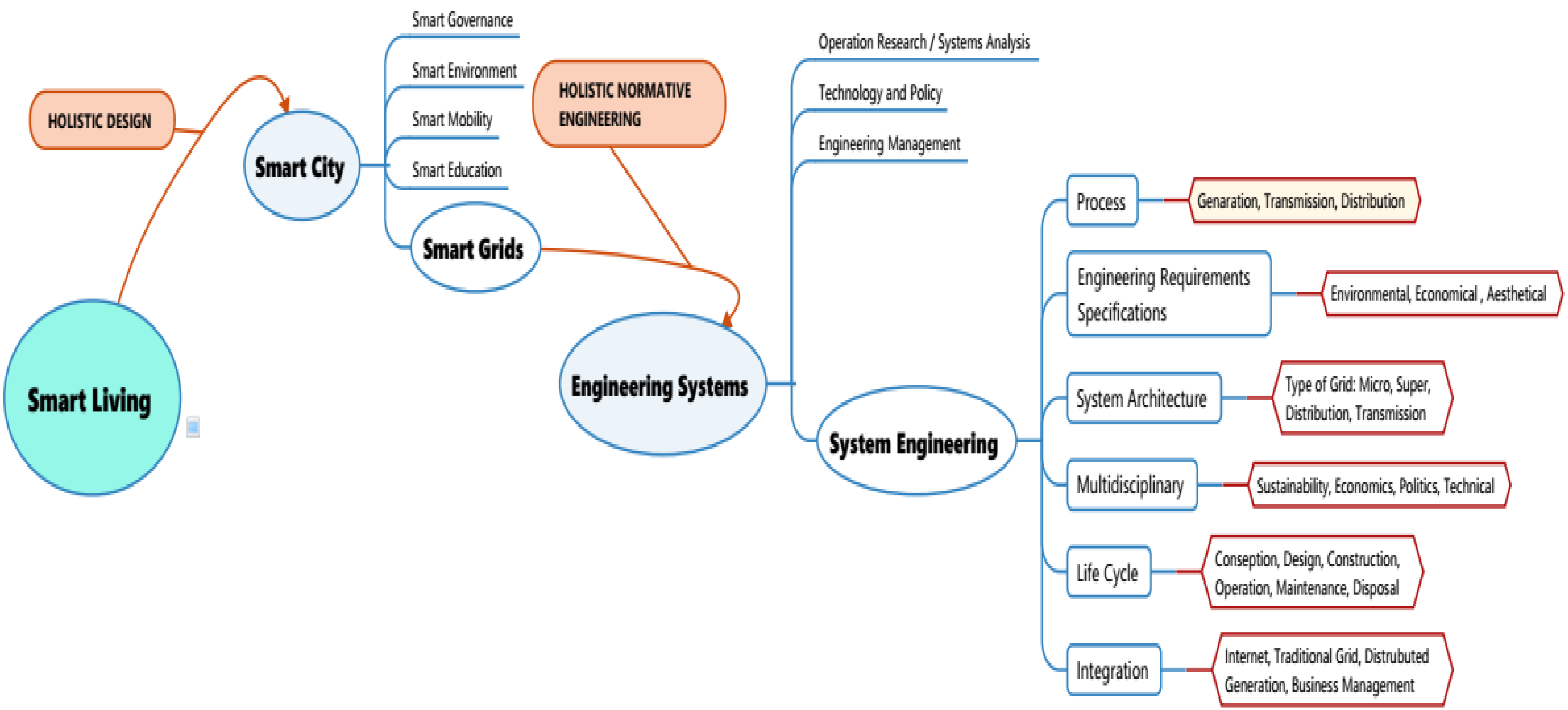
The main analytical tools for composing the framework are:

- **Philosophy of Technology: All Social Perspectives**
- **Engineering Systems: All Engineering Macro Systems**
- **Systems Engineering: All Engineering Processes**
- **Design Criteria: All Design Chracteristics**
- **Modal Aspects**

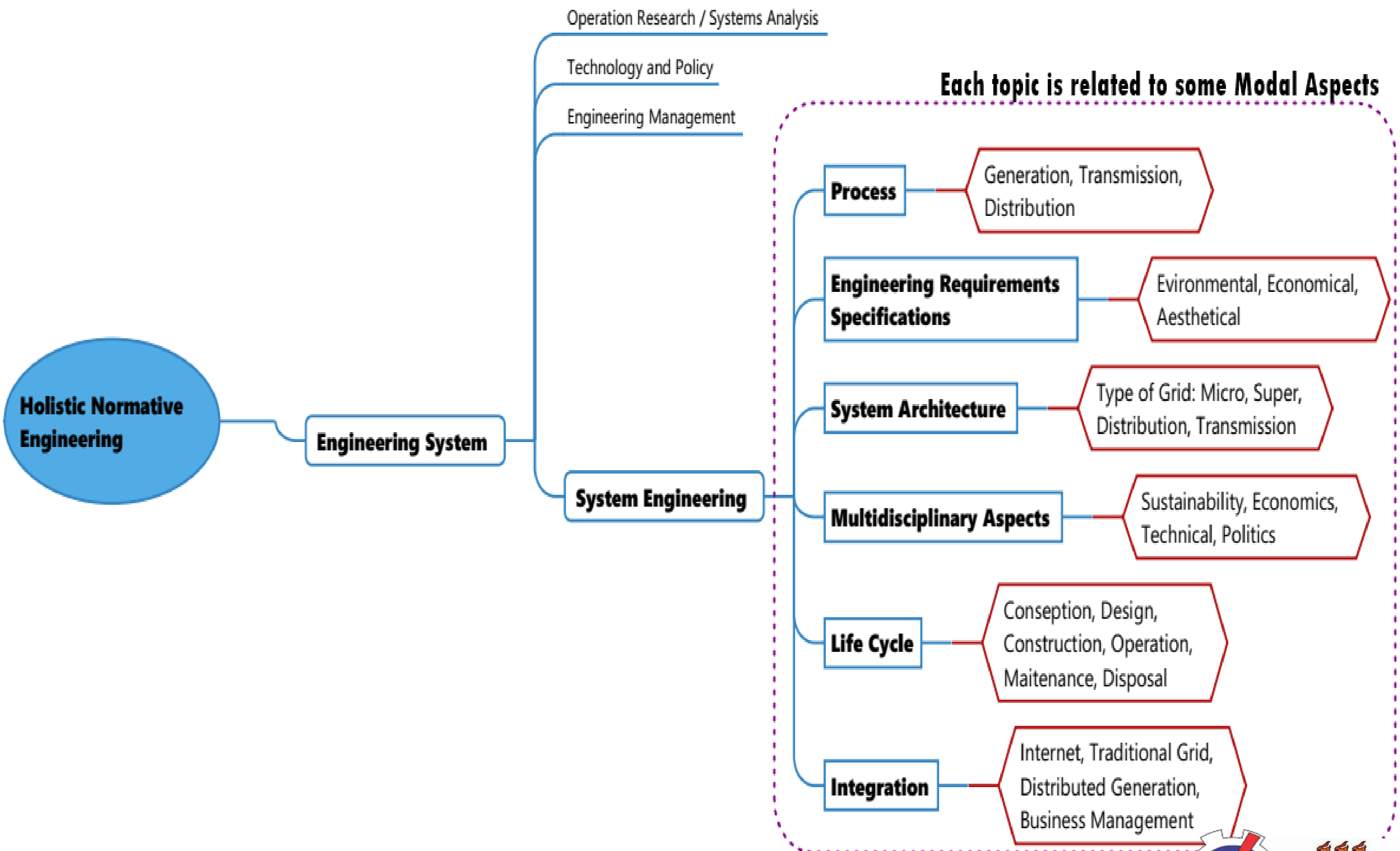
An Attempt to See the Issue from a Holistic Normative Integrated Way



An Attempt to See the Issue from a Holistic Integrated Way
All Starts with Smarter Living

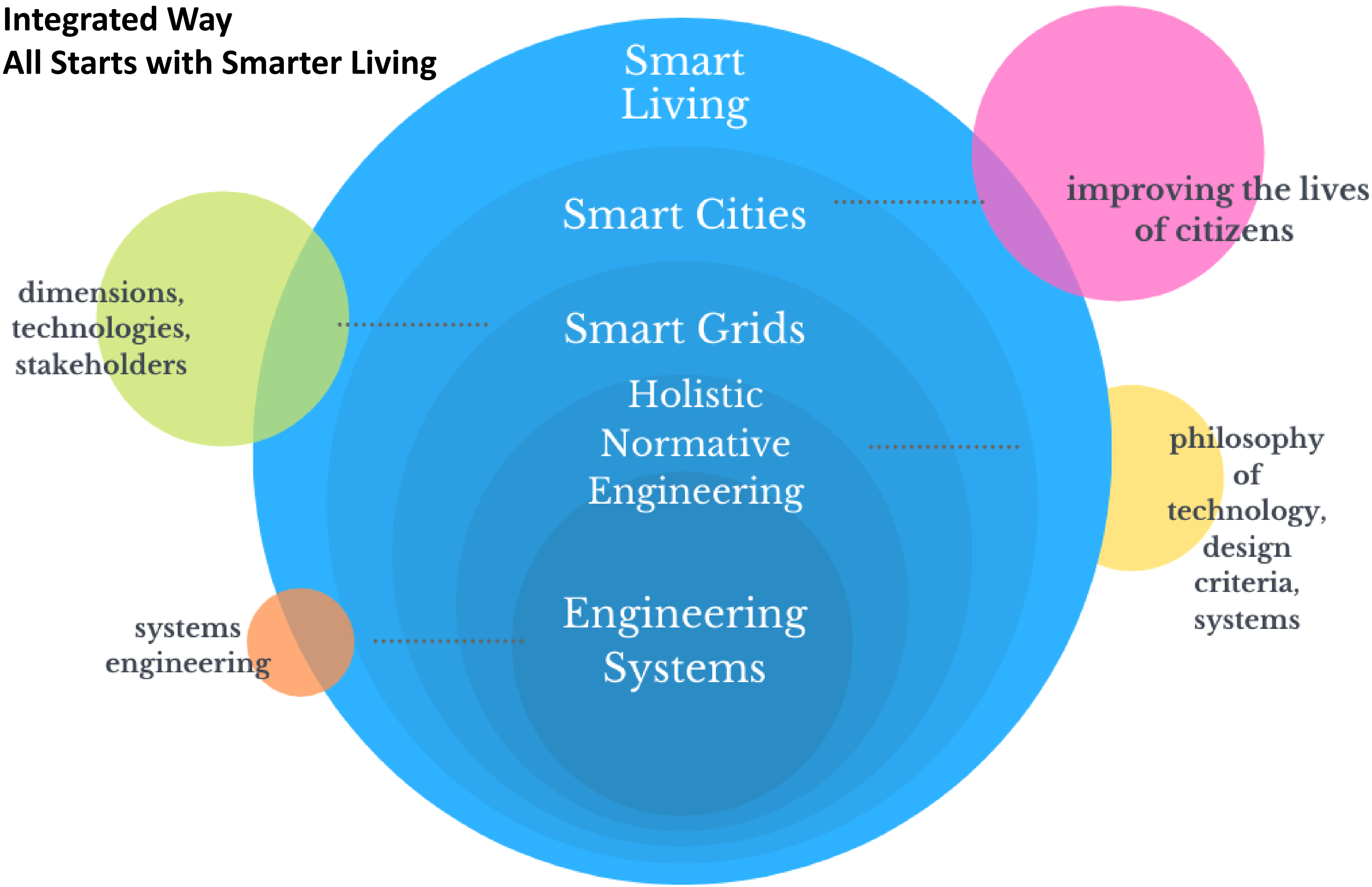


An Attempt to See the Issue in a Holistic Integrated Way



An Attempt to See the Issue from a Holistic Integrated Way

All Starts with Smarter Living



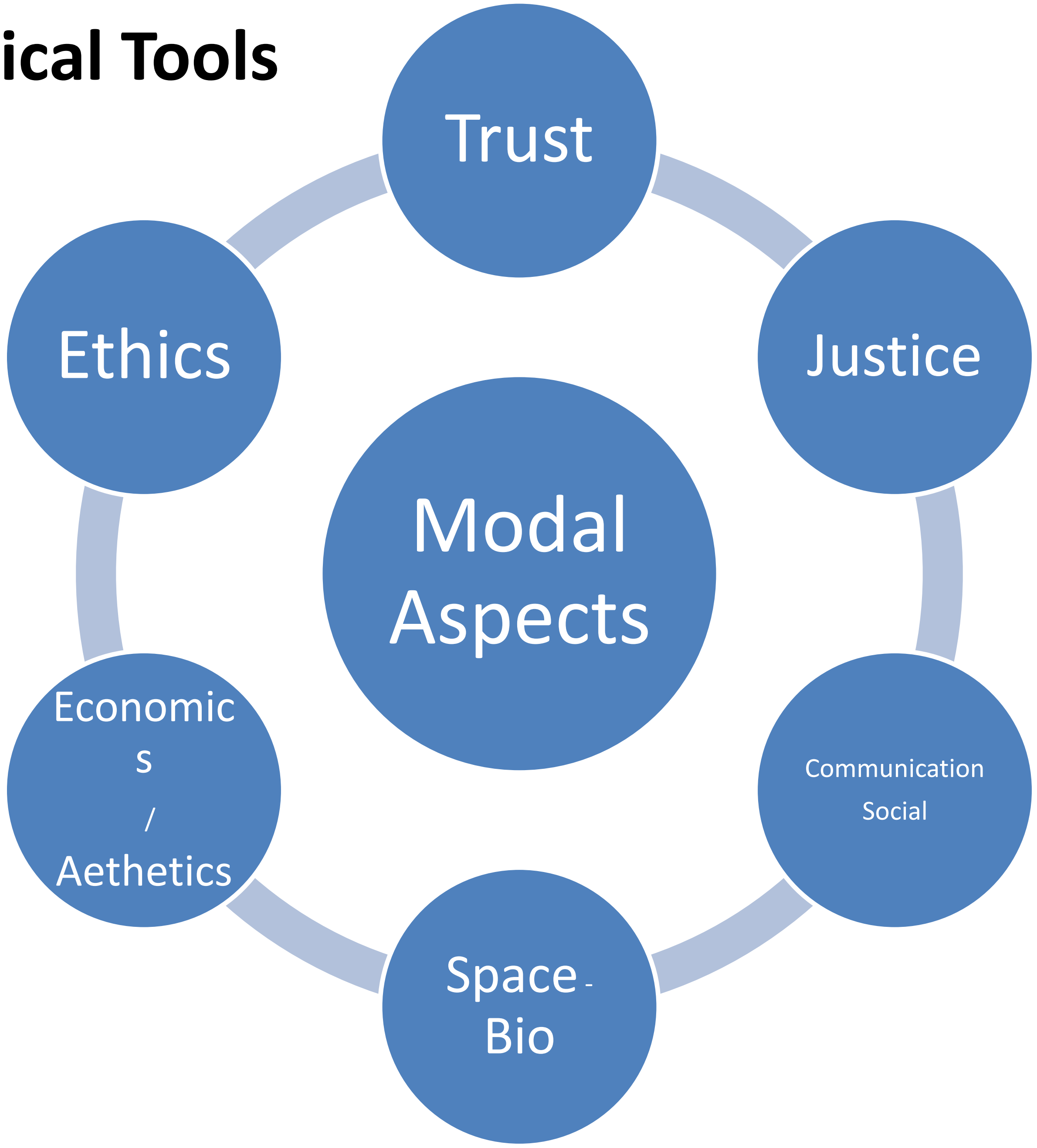
Smart >>>>> Smarter

Analytical Tools

Modal Aspects

Since each of these main activities involve complex relationships of all physical reality the Model Aspects developed by Dutch Philospher Herman Dooyweerd is used as an additional tool to help unfold the activities in a more integrated way.

Analytical Tools



Analytical Tools

Philosophy of Technology

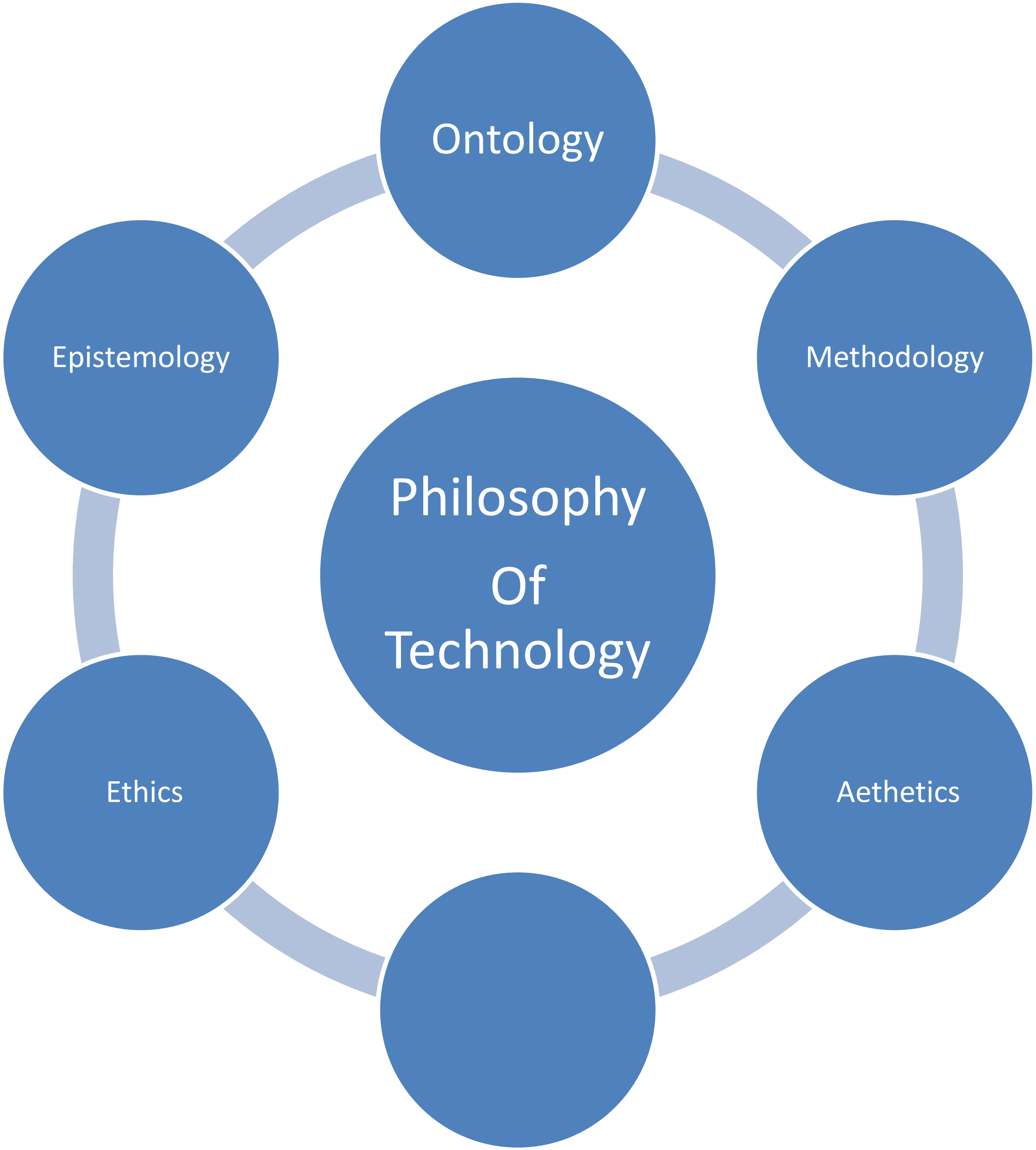
The philosophy of technology is a sub-field of philosophy that studies the nature of technology and its social implications and effects.

The Functions of Philosophy of Technology are:

Analytical: To bring clarity to the design process

Critical: Connected to the Analytical - to criticize – search for blind spots

Direction: Point the most reasonable and safe way


Ontology
Epistemology
Methodology
Philosophy
Of
Technology
Ethics
Aethetics

Analytical Tools

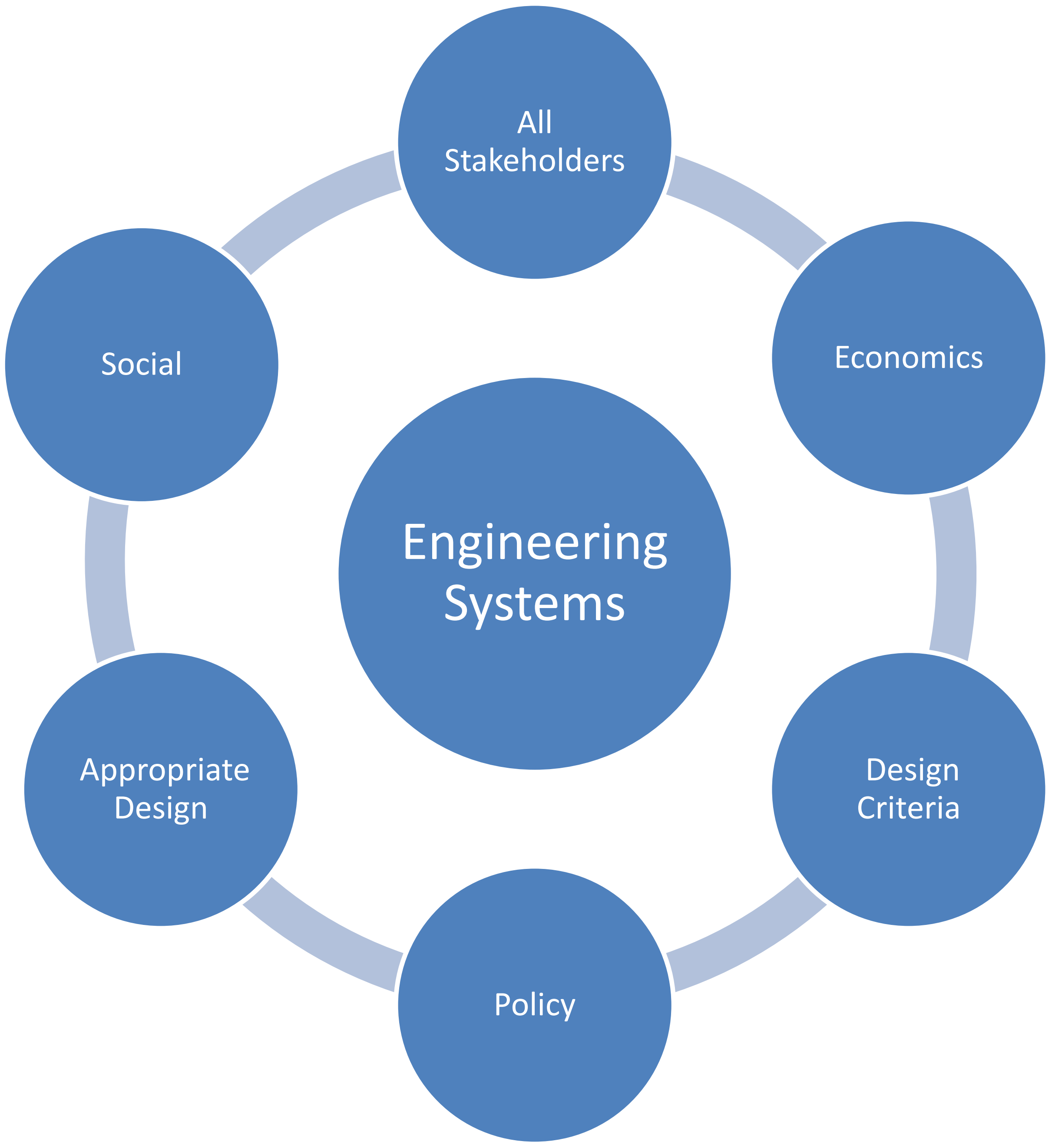
Engineering Systems

Engineering Systems are interested in the following characteristics:

- Technologically enabled
- **Large scale (large number of interconnections and components)**
- Complex
- Dynamic, involving multiple time scales and uncertainty
- Social and natural interactions with technology
- Likely to have emergent properties

The four underlying subfields for engineering systems are:

1. **Systems Engineering (including systems architecting and product development);**
2. Operations Research and Systems Analysis (including system dynamics);
3. Engineering Management; and
4. Technology & Policy.

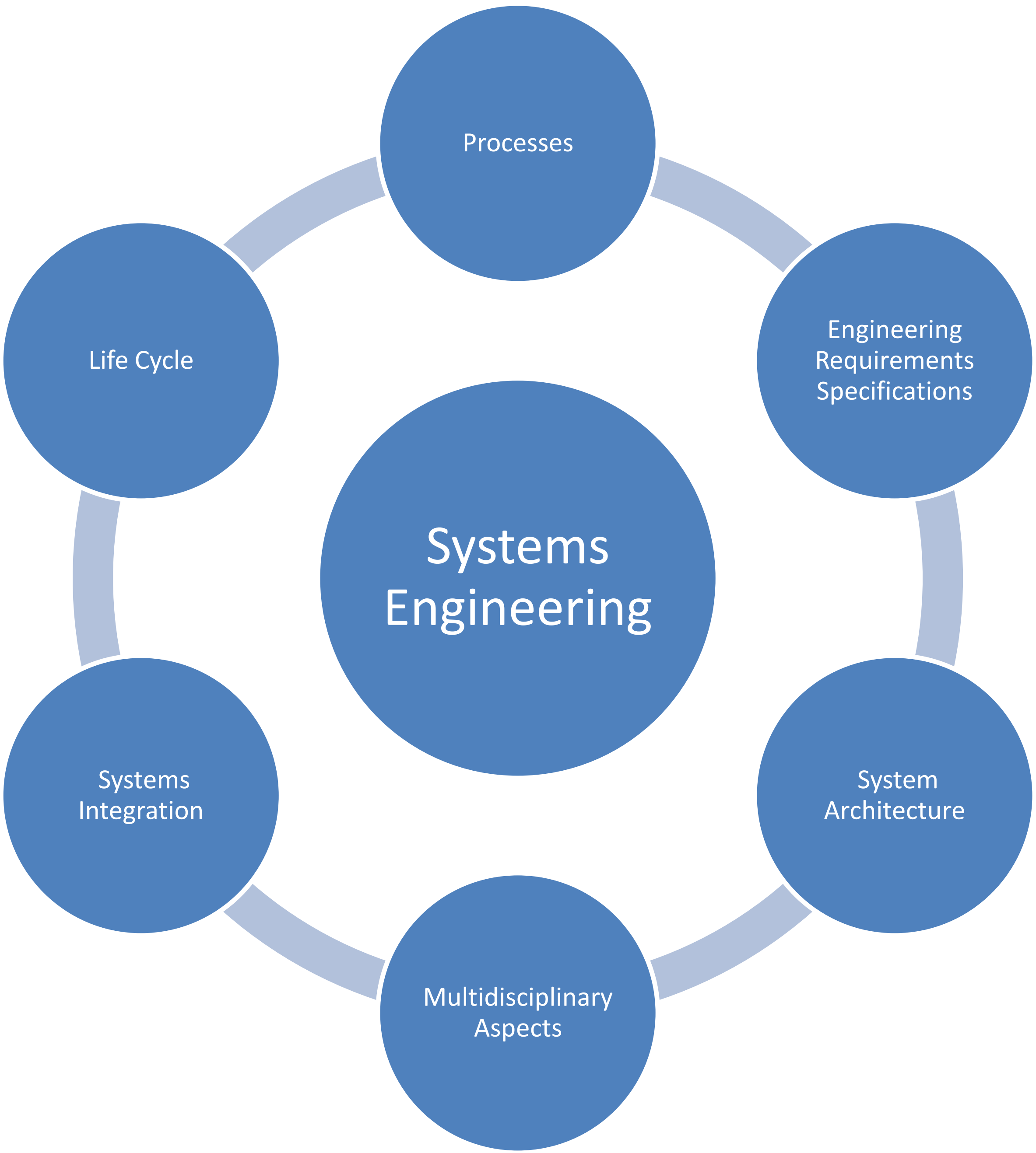

All Stakeholders
Economics
Design Criteria
Policy
Appropriate Design
Social
Engineering Systems

Analytical Tools

Systems Engineering

There are varied definitions for systems engineering;

1. Ramo (1984) – Systems Engineering is a branch of engineering that concentrates on the design and application of the whole as distinct from the parts…looking at the problem in its entirety, taking into account all the facets and variables and relating the social to the technical aspects.
2. INCOSE (1996) -- Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems.
3. Kossiakoff & Sweet (2003) – The function of Systems Engineering is to guide the engineering of complex systems. Systems Engineering is focused on the system as the whole – it emphasizes total operation. It looks at systems from the outside, that is, at its interactions with other systems and its environment, as well as from the inside.


Processes
Engineering Requirements Specifications
System Architecture
Multidisciplinary Aspects
Systems Integration
Life Cycle
Systems Engineering

Comparing

Aspect	Engineering Systems	System Engineering
Scope	**Very large-scale systems**, complex open systems	**Small to large scale systems**, subsystems, system of systems
Focus	**Broad, Overall view to the** technology/product system and project design	**Primary focused on technology/product system**
Policy	Optimized and adaptable system solution	Steady system solution
Socio-technical	Essential for systems solutions	Substantial in engineering
Stakeholders	Focus on all stakeholders impacted by the system	Priority focus on those directly impacted by the system
Roles	System architecture, business management, project design, social science, policy, economics, others	System architecture, performing of systems, engineering process

See Table 1a

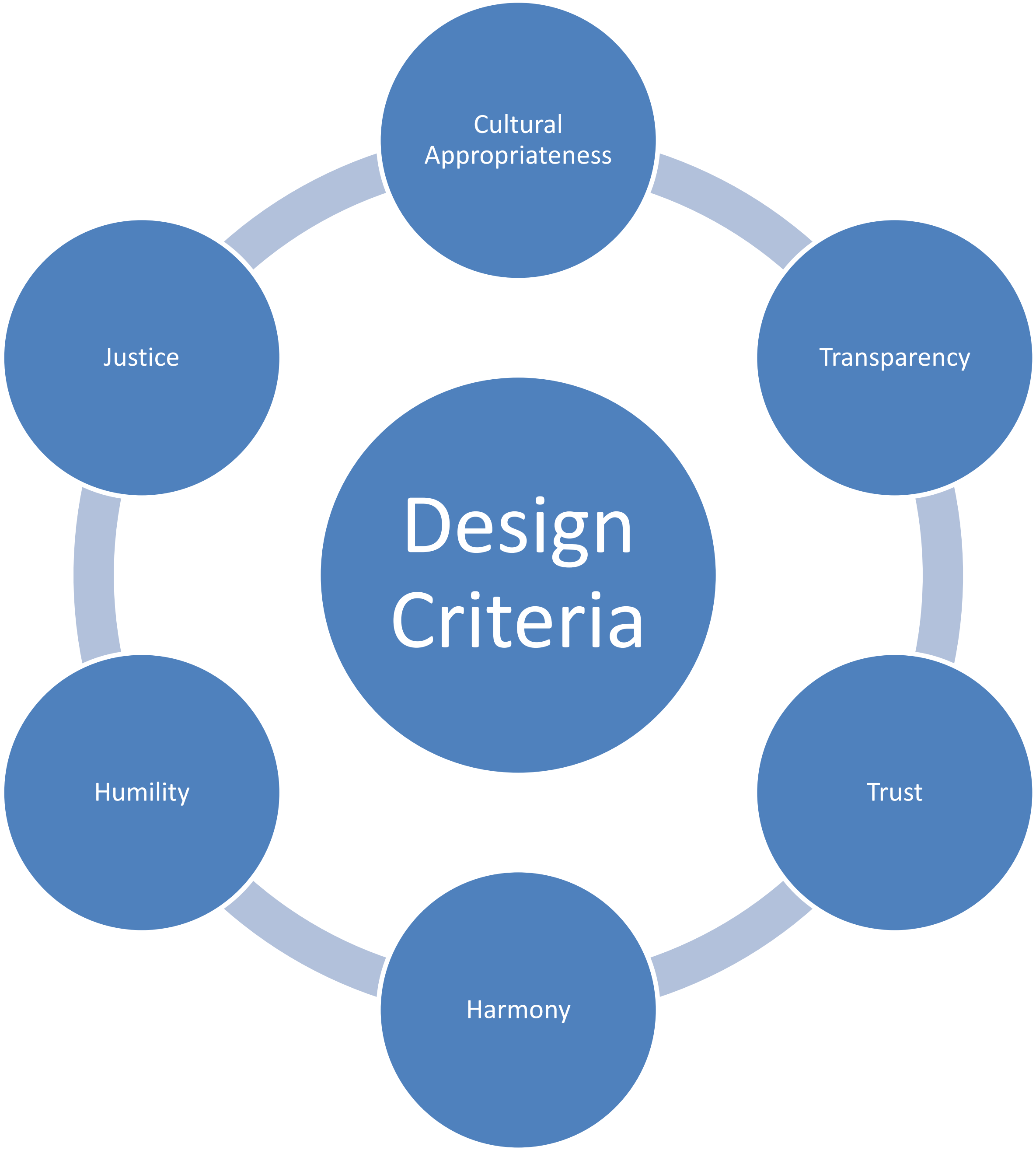
Aspect	Engineering Systems	System Engineering
Scope	**Eletric Power systems**, smart energy system	**PV generation system, isolated** microgrid system, substation
Focus	**Philosophy of technology**, design criteria, impact on human life	**Focus on technology, equipment, controllers**, applications
Policy	Use of solutions to adapt the advances of electric power systems in society	Use of standards, methodology, requirements
Socio-technical	Crucial for smart grid projects to present a holistic and empowering vision for society as a whole	Important for smart grids to work properly, matching quality and reliability
Stakeholders	Focus on environment, underprivileged by modern technologies, researchers	Focus on consumers, “prosumers”, energy agencies, professionals
Roles	Grids architecture, energy markets, projects design, social aspects from smart grids, politics, biology, others	Construction of new environments, smart grid performance, eletrical engineering, information and communication

Analytical Tools

Design Criteria – Normative Principles

The following aspects should be considered within a specific in design which point to Normative Principles:

- Point to the Normative Principles
- Cultural Appropriateness
- Transparency
- Stewardship
- Caring
- Justice
- Trust
- Delightful Harmony


Design Criteria
Cultural Appropriateness
Transparency
Trust
Harmony
Humility
Justice

Smarter Electric Grids
Applying Modal Aspects to Systems Engineering

Aspects	Electric grids	Smart grid
Arithmetic	Numbers	Measureable quantities: voltage, current and power
Spatial	Use of space	Transmission and distribution network
Kinematic	Moving components	Rotating generators, energy flow
Physical	Materials and properties	More efficient and intelligent cables, transformers, generators, etc.
Biotic	Influence on animals, human bodies, environment	Influence electromagnetic fields and waves on life
Psychic	Feelings of safety	Intermittent renewable sources lead to feelings of uncertainty
Analytical	Distinction between different types of grids	Clear identification of problems" for electric and "Clarity of energy policies and objectives" for smart?
Formative	Control	Control of power generation, distribution and consumption, smart meters

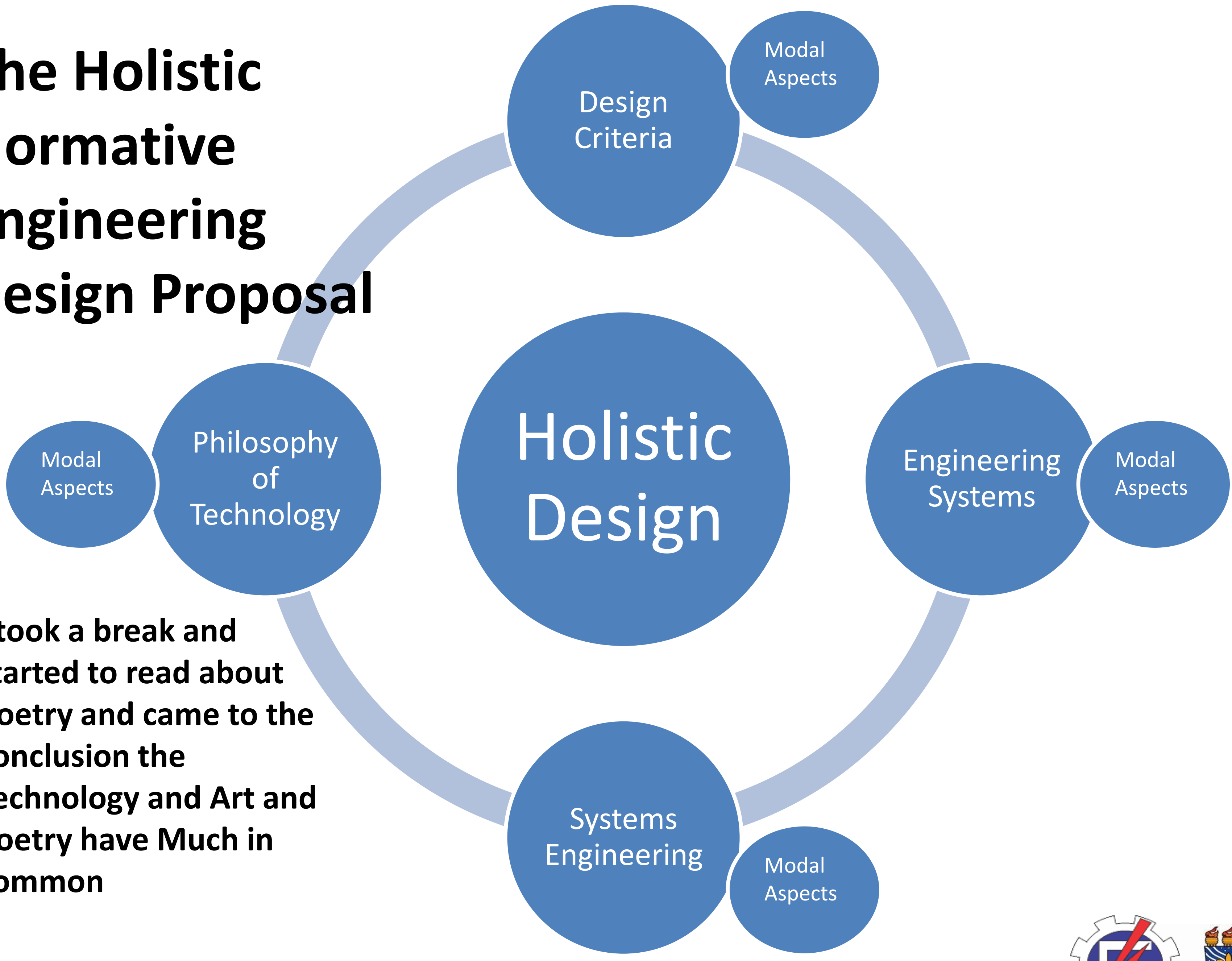
Smart Electric Grids
Applying Modal Aspects to Systems Engineering

Aspects	Electric grids	Smart grid
Lingual	Meaning of terminology	Term “smart” chosen to promote technology? Should it be Smarter?
Social	Influence on human behavior	Leads to more sustainable human behavior?
Economic	Cope with scarcity of energy and higher demands	Price differentiation depending on momentary supply and demand
Esthetic	Esthetics of buildings and systems	SGs are even better because they are trying more assiduously to a) harmonise variable sources, demand, breakdowns, etc. (b) there is a design challenge, to achieve such harmonisation.
Juridical	Liability, ownership of networks	Who is liable for a failing smart grid? When are Smart Grids appropriateness and when not?
Moral	Care for the environment, humans and animals	How do smart grids help in an intentional caring for humans and the environment?
Pistic	Trust the grid	Vision/Commitment/Belief on a Smarter Grid

Smart Electric Grids
Applying Modal Aspects to Engineering Systems

Stakeholder	Main interests
Government	Economical and juridical
Local authorities	Juridical and moral (safety)
Industry	Economical, reliability
Health care	Reliability
Households	Economical, social
Action groups	Moral (environmental, safety)
And so on …	

The Holistic Normative Engineering Design Proposal



I took a break and started to read about poetry and came to the conclusion the Technology and Art and Poetry have Much in common

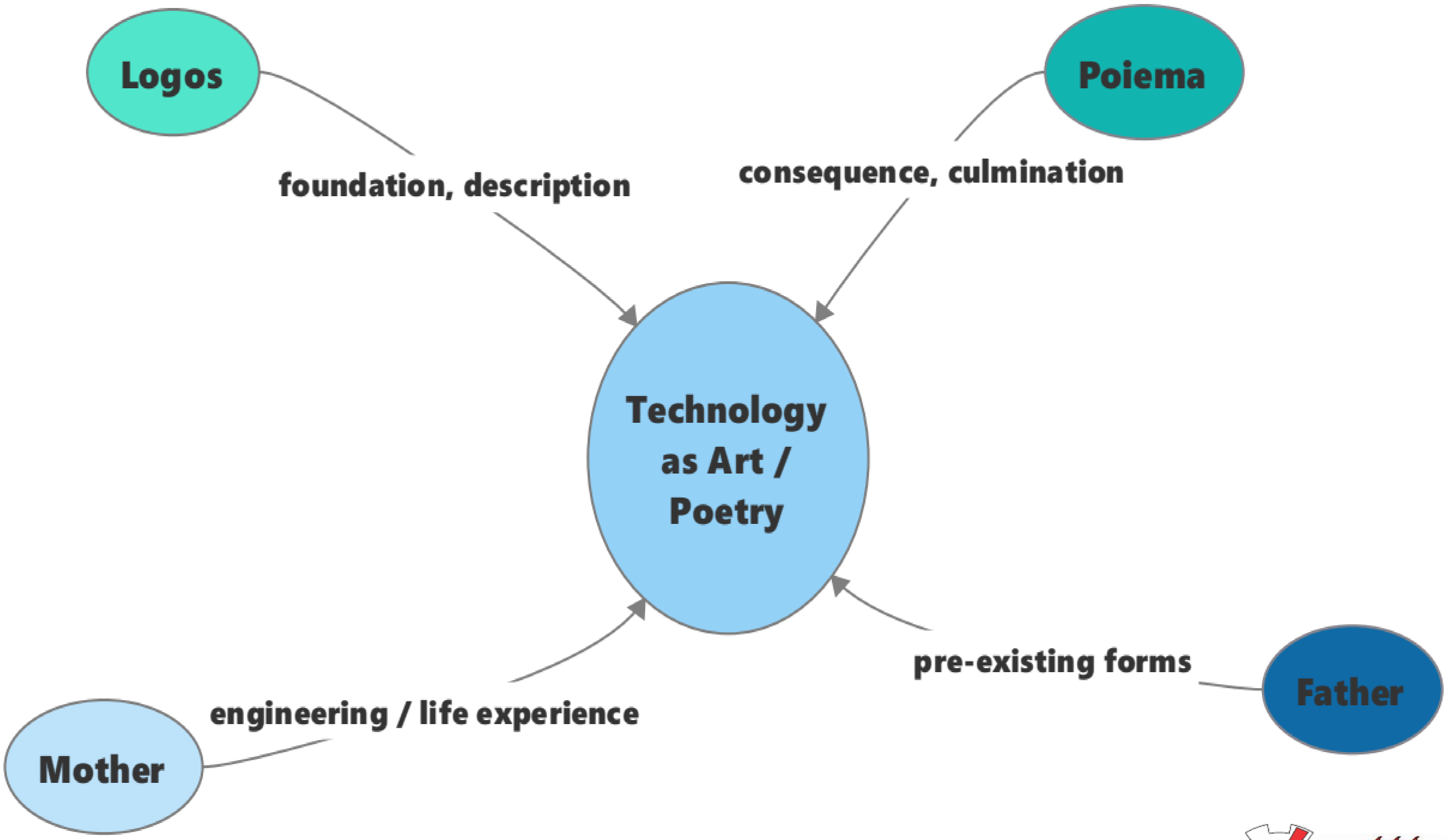
TECHNOLOGY AND POETRY

- Technology both means and is. It is both
  - Logos (something said) and
  - Poiema (something made).

- As Logos it tells a story of its development, expresses all the encountered complexities, exhorts, criticizes, and proposes new directions.

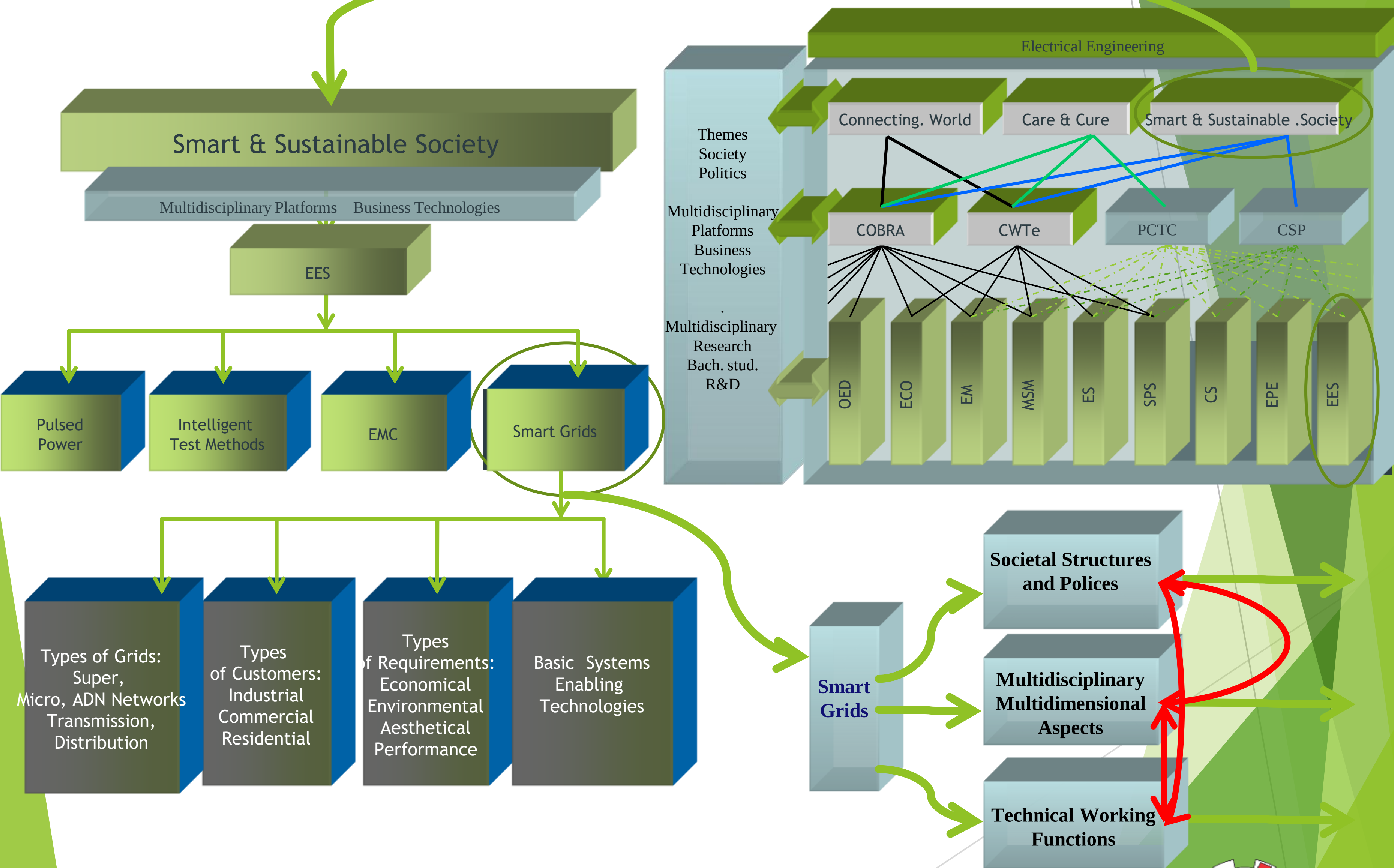
- As Poiema, engineering / technology by its splendors and beauties, harmony, contrasts, and integration of the multiplicity of many parts and sub-systems - it is an object of art.

TECHNOLOGY AND POETRY



An Overview

Smart Grids Framework



CONCLUSIONS

- **Technological Developments are Connected with Society – a Holistic Approach is Indispensable**

- **Philosophy of Technology is Necessity rather than an Academic Exercise**

- **Architectures of Reference and Normative Frameworks for Engineering Systems and Systems Engineering must be continually developed**

- **Technology is an Art – like a Poem, it requires an Imaginative Design that takes into account Normative Principles and Forms**

- **Modal Aspects, Systems Engineering …will enhance the understanding and proper development of all stages from conception to design, development, production, distribution, operation, environmental impact, maintenance, retirement, phase-out and disposal.**

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